

March 30, 2005

MEMORANDUM TO: David C. Lew, Chief  
Probabilistic Risk Analysis Branch  
Division of Risk Analysis & Applications  
Office of Nuclear Regulatory Research

FROM: Amarjit Singh, P.E. */RA/*  
Probabilistic Risk Analysis Branch  
Division of Risk Analysis & Applications  
Office of Nuclear Regulatory Research

Mary Drouin */RA/*  
Probabilistic Risk Analysis Branch  
Division of Risk Analysis & Applications  
Office of Nuclear Regulatory Research

SUBJECT: SUMMARY OF MARCH 14-16, 2005, PUBLIC WORKSHOP  
WITH INTERESTED STAKEHOLDERS ON WORKING DRAFT,  
"REGULATORY STRUCTURE FOR NEW PLANT LICENSING,  
PART 1: TECHNOLOGY-NEUTRAL FRAMEWORK"

The staff held a public workshop with interested stakeholders from March 14 -16, 2005, to discuss and solicit comments on preliminary working draft, "Regulatory Structure for New Plant Licensing, Part 1: Technology-Neutral Framework." The meeting was widely attended and included representatives from American Nuclear Society (ANS), American Society of Mechanical Engineers (ASME), Nuclear Energy Institute (NEI), Westinghouse, International Atomic Energy Agency (IAEA), General Atomic, Idaho National Laboratory, Lawrence Livermore National Laboratory (LLNL), Sandia National Laboratories (SNL), Framatome, Federal Emergency Management Agency (FEMA), PBMR Pty. Ltd., members of the Advisory Committee on Reactor Safeguards (ACRS), and various power reactor licensees and consultants.

The list of attendees and the meeting agenda are provided in Attachments 1 and 2, respectively.

Mr. Carl J. Paperiello, Director, Office of Nuclear Regulatory Research presented the opening remarks. His remarks included the following:

"I welcome you to our workshop on the technology-neutral framework for the regulatory structure for new plant licensing. We may about to enter an era for licensing the next generation of nuclear reactors which will likely involve new technologies with little resemblance to our current light water reactor designs.

Licensees have notified us of their interest to pursue early site permits. The National Commission on Energy Policy has recommended that the “Federal Government provide funding over the next 10 years for research, development, demonstration and deployment of one or two advanced reactors.” Senator Peter Domenici has proposed a bill that “supports the increased use of nuclear power and the construction and development of new and improved nuclear power plants.” The Department of Energy (DOE) is actively pursuing research in the development of advanced reactor designs, Generation IV reactors. The town of Galena, Alaska, has notified the Commission of their interest in the Toshiba 4S reactor. We need to prepare for this future so that we maintain the stability and predictability that we have in our current regulatory structure.

We have achieved this stability and predictability because of the experience we have gained over the last 30 years. I think that some of that has been very painful looking back on it. This experience has given us a solid knowledge-base regarding the design, construction and operation of light water reactors. We have established regulations governing the entire fuel cycle, from uranium mining, to fuel fabrication, to siting, to reactor design, construction and operation, to spent fuel storage, to high level waste repository. In developing these regulations, we have worked closely with professional societies in developing consensus standards. We have also developed, for example, regulatory guides, technical specifications, standard review plans, inspection programs all of which has led to establishing the stability and predictability in our current regulatory structure.

However, our current regulatory structure, our knowledge-base, is for light water reactors. For the new reactor technologies, we will be faced with design, construction, and operation issues that are different from the light water reactor technology. Our current regulations may have limited applicability for the future. These reactors, such as the High Temperature Gas Cooled Reactor and the Pebble Bed Modular Reactor, utilize significantly different fuel, moderator and coolant concepts and materials, and involve significantly different operating conditions for example, much higher operating temperatures for the DOE’s proposed gas-cooled reactor. These new designs will pose new challenges with complex policy and technical issues. They may pose safety concerns not addressed by the current set of regulations. Nonetheless, our experience has provided us with insights and lessons that will help formulate the fundamentals of a new regulatory structure. We have learned, for example, the importance of defense-in-depth, the benefit of integrating risk insights, the need to be performance-based. It is essential that as we move forward we do not abandon these things that have contributed to the stability and predictability of our current regulatory structure.

The staff has initiated a program for new plant licensing. This effort is currently focused on the design, construction and operation of the reactor. The staff has completed a working draft of the first part of this new regulatory structure: the development of a technology-neutral framework. This framework will provide the guidelines and criteria for developing a set of technology-neutral requirements.

We believe that this working draft is sufficiently developed to illustrate one possible way to establish a technology-neutral approach to future plant licensing, and to identify the key technical and policy issues to be addressed. In this regard, it can serve as a starting point, and I emphasize “starting point” for engaging stakeholders and facilitating discussion.

The framework has laid out an approach that addresses important technical and policy issues. For example, the safety philosophy for advanced reactors, what should be the level of safety for these new designs; risk objectives, what should be the figure of merit of achieving the quantitative health objectives, a frequency-consequence curve expressed in terms of curies released or in terms of dose; integrated risk, the risk posed by multiple reactors on a single site, should the integrated risk be based on a site or on a nationwide basis?

We look forward to the next three days and the technical discussions. However, this workshop, the formulation of this framework is just a first step as we move towards the future and new technologies. There is more work beyond the framework that will be needed for the licensing of the new reactors. There are other challenges than those addressed by the framework that will pose additional policy and technical issues. As these new technologies emerge, as they become more and more different than our current knowledge and experiences, the challenges will become more complex. If we are to achieve stability and predictability, it is essential that we identify and address these other challenges.

When you leave this workshop, and you think about the issues discussed, I would like for you to also start thinking what we have not addressed, the challenges not covered by this framework. For example, what new standards are needed, what will technical specifications look like, what ALARA requirements are needed for new technologies, how to ensure safety and quality of fuel material, what new designs are needed for spent fuel storage, what new shipping container designs will be needed for transportation? In addressing these issues, we will need creativity, we will need for all stakeholders to be involved.

Therefore, the message that I would like to leave with you is this. We are making significant advancements toward new plant licensing with this new framework, but we need to start working beyond the framework and address the entire fuel cycle.”

The workshop included (A) a short presentation by the NRC, (B) an open discussion among all the participants, breakout sessions focused on specific technical issues, and (C) formal presentations by stakeholders. Each of these are briefly summarized below. Handouts of the stakeholders and a transcript of the workshop is available (ML050890249, ML050890258, ML050890261).

## A. NRC PRESENTATION

The NRC presentation included an introduction and an overview of the regulatory structure for new plant licensing. The various elements of the presentation are summarized below.

### **Introduction: purpose of the workshop**

The purpose of this workshop was to solicit comments and public input on the staff's working draft on the "Regulatory Structure for New Plant Licensing, Part 1: Technology-Neutral Framework." The working draft was issued for public review and comment on January 25, 2005, and the public comment period ends on April 22, 2005.

### **Overview of Regulatory Structure, Policy and Technical Issues**

The staff's presentation included a high level summary of each element of the regulatory structure and the associated policy and technical issues.

### ***Background***

There have been four major SECY papers which provided the status of work and have identified the current policy and technical issues that are being addressed in the framework. The Commission has approved the staff's recommendation on some of them, but has asked additional information on the others. All of these issues will be identified in the framework document. SECY-05-0006 was provided to the Commission in January 2005 along with a copy of the working draft of the technology-neutral framework document and a status of the policy and technical issues that are being addressed in the framework.

### ***Regulatory Structure***

The staff's objective is to provide an approach to enhance the effectiveness and the efficiency of new plant licensing in the longer term such that the staff can achieve the stability and predictability that have existed for light water reactors. It provides the technical basis for future rulemaking for the technology-neutral regulations for new plant licensing. This regulatory structure will be applicable to all new plants, all types of new reactors such as High Temperature Gas Cooled Reactor, Pebble Bed Modular Reactor, and advanced light-water reactors such as IRIS. This regulatory structure is not intended for the designs currently under review. This will also address the risk to public, onsite workers and the environment. The staff has proceeded on Part 1, the technology-neutral framework, and to date, the staff has done enough work to demonstrate the feasibility of developing a technology-neutral framework. There are, however, difficult technical and policy issues that are being addressed by the staff that need to be resolved before the framework can be finalized and implemented.

### ***Technology-Neutral Framework***

A hierarchical approach that provides the process with associated guidelines and criteria for developing technology-neutral requirements has been developed. This framework consists of eight elements which include safety philosophy, protective strategies, risk objectives, design, construction, operation objectives, treatment of uncertainty, process to develop

technology-neutral requirements, performance-based concepts, and PRA technical acceptability.

### *Safety Philosophy*

The approach starts at the very high level with Atomic Energy Act and the mission of protecting the public health and safety by establishing what we call a “safety philosophy.” It sets at a very high level the safety goal that needs to be met. The framework proposes that the technology-neutral requirements for new reactor will be written to achieve at least the level of safety defined by the safety goal policy statement, the quantitative health objectives. Policy issue for Commission consideration.

### *Protective Strategies*

The safety philosophy can be accomplished by identifying “protective strategies.” The protective strategies are defining the safety fundamentals that are needed to protect the public health and safety and defines the building blocks for developing the technology-neutral requirements. The protective strategies provide a high level defense-in-depth. Protective strategies include physical protection, limit the initiating event frequency, protective systems, barrier integrity and accident management. Part of accident management is emergency planning, another policy issue.

### Emergency Planning

Following is a brief summary in the area of emergency planning, which is one of the protective strategies in the framework document:

- The effect of the proposed framework on emergency planning programs for evolutionary and advanced reactors was discussed. Nuclear reactor emergency planning was described as a mature program, which is regulated by both NRC and the Federal Emergency Management Agency (FEMA).
- The development of a technology-neutral framework for emergency planning would include a discussion of the possibility of reducing or eliminating the emergency planning zones (EPZS). This issue has been looked at over the last several years, and the most recent in-depth NRC review was in 1997 (which is summarized in SECY-97-020). The Commission has maintained that EPZ size reduction for evolutionary and advanced reactor designs is open for consideration. Any change to emergency planning, based on a risk-informed approach, could also affect emergency planning programs for the existing light water reactor fleet.
- NRC invited the industry, stakeholders, and the public to submit comments regarding how risks associated with evolutionary and advanced reactors should affect emergency planning, including EPZ size.

### *Risk Objectives and Design/Construction/Operation Objectives*

The risk objectives address the risk to the public, operating staff and environment. For the public, the risk objectives, via either a frequency-consequence curve or surrogates, sets frequency limits on the possible consequences of accidents to ensure that NRC's safety goals are met. For the operating staff, new risk goals are not needed; the risk to the operating staff is addressed via current regulations. For the environment, there are no requirements for protection from accidents of nuclear power plants. The Framework uses an approach to demonstrate that the environment is being protected at least as well as the public.

Design objectives provide probabilistic criteria for accidents for the selection of events which must be considered in the design and which constitutes "design basis events." They also provide probabilistic criteria for the safety classification of systems, structures, and components and to replace the single failure criterion. Design objectives includes a policy issue for Commission consideration: the integrated risk posed by modular or multiple reactors at the same site. The evaluation of integrated risk considers that accident prevention goals are important regardless of reactor power level and accident mitigation goals may be dependent on reactor power level.

The construction and operational objectives being developed are in the early stages.

### *Treatment of Uncertainties*

The Commission approved the staff's recommendation for developing a definition of defense-in-depth that would be incorporated in update of PRA Policy Statement. Uncertainties are associated with design, construction and operation, therefore, a defense-in-depth approach that it is an integral part of the framework is needed. Key defense-in-depth principles have been defined. A model has been developed where the principles are applied. The model is a combination of structuralist (deterministic) and rationalist (probabilistic) elements. The consideration of containment in meeting the barrier integrity protective strategy is another key policy issue.

### *Process for Technology-Neutral Requirements Development*

Process for developing the requirements is to first identify and define the scope and content of detailed technical and administrative requirements that are necessary to ensure the safety objectives and criteria are met. For each protective strategy, the potential challenges and threats that would prevent the accomplishment of that strategy are identified. Requirements are developed to prevent the challenges and threats from occurring. After the scope and content of the technical and administrative requirements are identified, a check on their completeness, practicality and implications will be performed.

### *Performance-Based Concepts*

This framework is consistent with the Commission's white paper on risk-informed, performance-based regulation. There will be margins of performance that must ensure that failure to meet a performance criterion will not be an immediate safety concern. This should include adequate safety margins, time available for corrective action, licensee's capability of



detecting and correcting degradation conditions. It should have measurable, calculable, or constructable parameters so that the staff can monitor the plants and licensee's performance consistent with defense-in-depth and uncertainty considerations. The licensees should have flexibility in meeting the criteria.

#### *PRA Technical Acceptability*

A full-scope, living PRA will be required. This will include a PRA with increasing level of detail from the design, construction, to the operation of the plant. The PRA will be updated over the life of the plant as operational changes are made and information becomes available. The uncertainties need to be addressed. The current standards will need to be reviewed and modified to support new designs.

#### B. OPEN DISCUSSION

A summary of the comments from participants during the open discussion are presented below.

- The Safety Goal Policy has been applied on a per plant basis since its inception. It was a major effort to establish and apply it to the existing fleet of reactors. Revising it to apply on a site, national or integrated basis over modular plants is unnecessary at this time. It will be many years before the national risk from modular plants, or site risks from modular plants becomes a sufficient concern. The time to revisit the issue and develop consensus is not a good use of resources. The single plant goal can be used to guide the risk informed application to modular plants on a case-by-case application. When there is enough demand for such plants, a change in the nationally or site risk characteristics can then be considered.
- With regard to the risk objectives, a frequency-consequence curve is the right approach, but believed that two curves were needed, one for set of sequences and another for the cumulative frequency.
- Concerns were raised regarding applicability of CDF and LERF for new reactors. Definition of CDF is not the same for current LWR and advanced reactors. The best approach is to acknowledge that this new technology will have new risks. One of the stakeholders raised the question if flexibility will be given on risk reduction to the industry in terms of the first two strategies (initiating events and protective systems).
- With regard to the design objectives, the basis for the frequency categories and the definition of event sequences need to be provided. The process for how to work out a licensing and design basis fluctuation with time needs to be addressed. One stakeholder felt that a relaxation of the single failure criterion would result in a more robust design because common cause failures, which are outside the design basis, will have to be addressed.
- Differing views on whether risk should be treated on reactor, plant, site or nationwide basis.

- There was some belief that the construction objectives were characterizing existing practices as new issues, such as non-US fabricated components.
- The process in developing requirements from the protective strategies needs to address commonalities, the protective strategies are not independent.
- Before considering all the issues with a risk-informed approach, the staff should consider the requirements without the risk-informed approach. These would lead to focusing on the research and development (R&D) and prototype testing needed. Following this, the PRA should be used to not only support assessment of the designs but the adequacy of the R&D and prototype testing.
- Would not use, "Defense-in-Depth: Treatment of Uncertainties" or "Treatment of Uncertainties: DID." In case of Generation IV reactors, the R&D and prototype testing are a dominant factor in reducing uncertainty. The idea that defense-in-depth covers some residual uncertainties or unknowns is important, but these residuals are expected to be very small in any licensed reactor. Defense-in-depth seems to fit more into the area of providing margin than in area of addressing uncertainties.
- Research and development should be expanded and applied to all "new" plant applications. The scope of this program, in addition to the existing data from light water reactor experience will be the real information base supporting the risk-informed design, construction, and operation. The information (data) required should be driven by the PRA and performance requirements of the design, construction and operation.
- There is not enough credit provided for the research and development and testing that industry has performed on the new designs.
- Additional examples are needed throughout the framework to better illustrate the concepts. In addition, testing of the framework was highly recommended.
- Development of PRA process and standards should be started by the standards committees right away.

## C. BREAKOUT SESSIONS

There were four breakout sessions: (1) containment performance requirements, (2) quantitative criteria and values, (3) treatment of uncertainties and defense-in-depth, (4) protective strategies and process for developing requirements.

### Session 1: Containment Performance Requirements

There were three parallel groups for this topic. Following is summary for each group:

#### **Group A:**

- There were questions about what the basis would be for deciding the credible events. The major question was whether the staff would keep looking for events having severe



containment challenge events until one was found that would sufficiently challenge the containment regardless of its frequency.

- There were views that there was a need for some guidance on which events would be considered credible and which events would not be considered credible. By requiring the containment barrier to have a separate capability to control leakage and release, the staff could foreclose on other viable approaches to preventing core degradation or preventing elevated releases. The issue of containment functional performance should be addressed in the SECY paper by addressing all of the important safety functions, not just the potential function as a radionuclide barrier.
- It was unclear how the mechanistic source term would be used in the safety analysis calculations to determine site suitability. The proposed source term is different than what is being used for the current early site permit reviews.
- It was unclear what the staff means by a single element of design construction or operation.

**Group B:**

- As a generic comment regarding all the option descriptions, the group felt that additional clarification in the write-up would be helpful. For example, does each successive option build on the previous one? That is, does Option 2 encompass all that is in Option 1 plus the added sequences, does Option 3 encompass all of 2 plus the controlled leakage, etc. This was not completely clear since the wording for each option implied this was the case, but the discussion sometimes did not. For example Option 3 discussion states *"this option is the same as Option 1, but includes the prescriptive statement...."* Based on the wording in the Option 3 description one would have thought the statement would be: *"This option is the same as Option 2, but...."* This is important because it determines similarities or differences in dose criteria, timing, etc.
- Regarding Option 2, there was a question of how the additional credible (but presumably rare) events would be selected, and what dose limits would have to be met for these events. It was noted that this additional consideration would also reduce the 'predictability' of what would be required by the option. Also, the term 'cost-effective' was felt to be inappropriate by some, since safety is the issue here and this is not a backfit consideration.
- For Option 3 the group raised the question whether the controlled release did not imply the capability for early venting. It was also felt this option could be special case of Option 2.
- Regarding Option 4, the question of what is meant by 'essentially leak tight' was raised. It was also pointed out that this option appeared to be more restrictive than the requirements for the containment of current reactors, since Option 4 would include severe accidents in the design requirements.
- Overall the group concluded that Option 2 was most appropriate for a

technology-neutral option. It would be tailored to specific technologies, for example to take a form similar to Option 3 for high temperature gas reactors.

**Group C:**

- The functional requirements are a good and complete set. There were some who thought that breaking out prevention of chemical attack as a seventh function would be helpful, but not essential.
- These are *containment function* requirements (as opposed to reactor building requirements).
- The entire design should meet the functional requirements, i.e., evaluation should be against all six functions and should consider the complete design, not just the reactor building.
- Meeting the 6<sup>th</sup> function, “reducing radionuclide releases,” should require meeting a specific frequency-consequence curve criteria.
- Meeting all six functions should also require meeting flexibility requirements
- Some rewriting of the SECY and Attachment 2 would appear necessary to properly convey the authors’ intent. While a careful reading of Option 2 speaks of functions, rather than a thing (reactor building), every member of the group was sure the document and all options referred specifically to a thing (a building).

**Session 2: Protective Strategies and Process for Developing Requirements*****Protective Strategies***

- Overview: appears to be a good and complete set; however clarification is needed.
- Protective strategies generated no opposition, but only a few participants had much to say about them.
- Some saw a need for a protective strategy on human performance, although, the group agreed that at least it needed a clear statement approach to ensure that a human action could not defeat all protective strategies.
- For all protective strategies: balance among them depends on PRA and some accounting for unknowns and uncertainty to assure that their function will still be met when things turn out differently than expected; details will be design-specific.
- Discussion on Emergency Planning as part of Accident Management Protective Strategy.
- Both FEMA and NRC representatives felt that it would be possible to modify EP requirements.

***Process for Developing Requirements***

- Performance-Based principles are good and complete set.
- PRA Technical Acceptance appears to be formulated in a reasonable way, but Appendix D needs to be written to document the ideas and some revised PRA standards are probably needed.
- Process for developing technology-neutral requirements from protective strategies appears to be reasonable, but Chapter 6 needs to be expanded to provide more complete explanations and examples.
- Chapter 6 needs substantial additional detail, especially on how PRA informs process, including development of performance-based requirements (such as R & D needs, tests, and monitoring).
- It would be good to find a way to clearly display the roles of PRA and performance requirements in the highest level descriptions of the framework.
- While the purpose of framework is to guide the development of technology-neutral requirements, these competing/complementary aspects create a complex interface. When will designer/applicants and regulators interact? Some participants suggested that this complex interaction between evolving design and PRA coupled with development of design-specific guidelines could call for a new paradigm of interaction. At a minimum, all hope that the framework will provide sufficient clarity to designers so that their process can have confidence in how the regulatory process will evolve. For now, it was suggested that examples of anticipated products from Parts 2 and 4 be presents in Chapter 1, so all can have a common vision of the expected form of these products.
- Consider the question on viewgraph 67, "Is it reasonable and practical to maintain a living PRA, which would be used to periodically reclassify reactor accidents as operating experience accrues?" This is a difficult issue and it is not split along industry vs. regulatory lines. One designer said that there is no other possibility. Others said that without DBE set, licensing cannot work. The process must be worked out in more detail to allow more thorough discussion. Most participants acknowledged that, as new technical information becomes available, requirements must change and have always changed.

**Session 3: Defense-in-Depth**

- There was general agreement with the premise that ultimate rationale or need of defense-in-depth (DID) was to compensate for uncertainty.
- The objectives of DID as stated at the beginning of Section 5.3.1 need to be reworked to include the fact that DID's objective is to compensate for both known and unknown uncertainties, as discussed in the beginning of Section 5.3.

- There were number of opinions regarding DID principles. Some were felt to be more 'principle-like' than others. In particular, the first principle, "*measures against intentional as well as inadvertent should be provided*," sounded more like scope issue than principle. Also, some of the terminology in the principles needs to be better defined (this was true for other sections of the framework as well). For example, what exactly is meant by the term 'single element of design, construction, or operation' ?
- The DID model as shown in Figure 5-1 of working draft framework document was generally regarded as sound. There was felt to be a need for discussion on the degree of independence of the layers of DID, "i.e., the protective strategies". This means investigating cross-cutting issues that could affect two or more strategies simultaneously.
- There was considerable discussion regarding the application DID as summarized Figure 5-2 of the working draft framework document. It was pointed out that a better explanation is needed for how the approach addresses completeness uncertainty, especially that which comes from the things we do not know, "i.e., which are not modeled or even anticipated in the PRA". The explanation should further clarify the role of the structuralist part of the application of DID including the principles, and emphasize the important role that monitoring and feedback has in validating (or modifying) the PRA assumptions. This should eliminate the impression that only rationalist elements found in PRA model are used to determine how much DID is sufficient.
- It was also pointed out that when DID elements, in addition to those that can be shown to have a quantitative risk benefit, are added, there should still be some justification required, in terms of the qualitative benefit of these DID features, before they are accepted as necessary. The discussion also noted that some DID measures in place at the early stages of a particular technology's implementation, may be rescinded later as the experience with that technology matures.
- The group expressed the opinion that it would be informative and useful to compare the DID approach in the framework with that endorsed in the IAEA DID approach.
- An example would greatly help the understanding and demonstrate the feasibility of the approach. The example could be performed using an existing LWR design, or a PBMR design, or both, depending on resources.

#### **Session 4: Quantitative Criteria and Values**

- Need two types frequency-consequence (FC) curves
  - < Regulatory acceptance FC curve (CCDF)
  - < Design FC curve (per scenario scatter plot)
- The consequence in the regulatory acceptance FC curve should directly relate to public health and safety (e.g., acute fatalities, total societal cost, etc.).
- Specify the level for defining scenarios (functional, systematic, component).

- Level 3 PRA to use the regulatory acceptance FC curve will be required.
- Specify the assumptions to be used in formulating the FC curves for example whole plant or only safety-related equipment.
- Define the terms best estimate and 95% confidence.
- The phrases “core damage” and fuel “damage” may not be technology-neutral.
- If you meet the FC curve, why be concerned with number of intact barriers.
- Skeptical that useable definitions of technology-neutral risk surrogates (accident prevention, accident mitigation) can ever defined. This may be possible for specific reactor types.

#### D. STAKEHOLDER PRESENTATIONS

##### **Marco Gasparini, IAEA Activity on Safety of Innovative designs**

Mr. Marco Gasparini, International Atomic Energy Agency (IAEA) briefly presented the activities on safety of innovative designs which are being performed by the IAEA. The purpose of this activity is to prepare technology-neutral requirements for new reactors. IAEA has published two main safety reports. The first document is for Defense-in-Depth in nuclear safety. This document was prepared by the International Nuclear Safety Advisory Group (INSAG) in 1996. The second document contains the development of safety requirements for innovative reactors.

The first objective is to have an internationally accepted safety approach for innovative small and medium sized reactors. These requirements will be applied to modular high temperature gas cooled reactors. Second objective is to achieve consensus on the scheme of safety compliance check of innovative reactors (need for designs licensable in several countries and need to simplify the licensing procedures). A new safety approach should be understandable, flexible, risk-informed, and performance-based. Safety goals are derived from the safety objectives, expressed by a frequency-consequence curve.

##### **Mark R. Holbrook, Idaho National Laboratory-Protective Strategy Example, Barrier Integrity**

Mr. Holbrook briefly presented an example of applying the Barrier Integrity protective strategy in developing requirements for the PBMR. Following is the summary of the presentation:

- Presented a high level summary of the framework structure and protective strategies.
- Summarized the framework process for developing requirements:
  - Perform top-down analysis
    - < Fault trees

- < Each branch ends with a set of questions related to the respective potential root cause failure
  - Answers to questions reveal the types of requirements needed to ensure that protective strategies are implemented
  - Used to develop a set of topics to assist development of technology-neutral requirements
  - Ensure that there are barriers to protect the public from accidental radioactive releases
  - Ensure that adequate barriers are maintained to protect public and workers during normal and shutdown modes of operation
  - Limit consequences of reactor accidents if they occur
- Summarized process for Barrier Integrity utilizing examples
    - HTGR Barrier Integrity Example
      - < TRISO fuel particle
      - < Reactor coolant piping
      - < Citadel structure (confinement)
    - PBMR Barrier Integrity Example
      - < TRISO fuel particle
      - < Fuel kernel- UO<sub>2</sub> or UC
      - < Failure fraction <6x10<sup>-5</sup> of particle inventory
      - < No measurable damage up to 1600 C
      - < Measurable damage above 1800 C
      - < Large scale coating damage above 2200 C
      - < Average core power density -4.8 MWt/m<sup>2</sup>
  - Conclusions from examples: Barrier integrity strategy questions focus attention on the following areas:
    - Accident selection
    - Research and development
    - Testing
    - Quality assurance
    - Human performance issues

### **Shawn Burns, Sandia National Laboratories- Probabilistic Risk Analysis, Quality Issues for New Nuclear Power Plant Licensing**

Mr. Burns presented a brief summary of probabilistic risk analysis of quality issues for new nuclear power plant licensing including: quality of PRA design and features, technology specific issues, and guidance documents for the framework. Following are highlights of these issues.



***Quality PRA Design and Features***

- Life-cycle process (living PRA)
  - Design
  - Licensing
  - Operation
  - Aging
  - Decommissioning
- Scope
  - All operating modes
  - Internal and external events
  - Safeguards and security
  - Uncertainty Quantification
  -
- Safety Classification
- Dynamic Modeling
- Human Event Analysis

***Technology Specific Issues***

- New Fuel Designs
- Passive Systems
- Digital Instrumentation and Control
- Smart Systems (Software reliability and Human interactions)

***Conclusion***

It will be required to provide methodology guidance which has a gap between regulatory abstraction and practical application. The guidance documents need to be updated such as Regulatory Guide 1.200 and the associated PRA standards (ASME and ANS).

**Nuclear Energy Institute (NEI) Comments on SECY-05-0006, Cedric Jobe**

Mr. Jobe provided comments on the behalf of the industry and NEI on the SECY-05-0006. Following is summary of industry goals and general comments on the proposed framework document.

***Industry Overall Goals***

- Framework should be developed to support Generation IV advanced reactor deployment.
- Opportunity to develop, test and build both NRC and industry experience in using new framework prior to commercial deployment of advanced reactors circa 2020.

- The framework should reflect the principles including iterative design and PRA assessments.
- Use prototype development and NRC reviews to assess and develop new regulations and framework.

***General Comments***

- Need overall project plan to move from proposed framework to final regulations post prototype testing.
- NRC should develop a schedule that targets an ANPR for early FY 2006.
- The framework structure should be aligned with the reactor oversight process (ROP).
- Writing requirements to meet the QHO's is acceptable.
- Should follow ALWR model as directed by Commission in SRM in SECY-03-0047.
- Integrated risk should support statements in the framework document.
- Defense-in-depth strategies need to incorporate both probabilistic and deterministic considerations.
- The use of F-C curves in lieu of current LWR surrogates is acceptable to demonstrate that the goals of Safety Goal Policy are met.
- The adequacy of structuralist defense-in-depth measures to address uncertainties identified by PRA must be demonstrable.
- Fuel and Spent Fuel disposal should be a parallel activity.

***Industry Proposed Time line***

- Early FY 2006 ANPR
- Early FY 2008 NOPR
- FY 2007 application for first design approval for advanced reactor
- Regulations to be tested against review of first advanced reactor design (s)
- Regulations to be updated on basis of prototype testing results
- Designs certified based on new regulations

**Bryan A. Erler, American Society of Mechanical Engineers (ASME) - ASME Initiatives in support of New Reactors**

Mr. Erler presented a brief summary of ASME initiatives in support of new reactors. ASME formed three groups: new reactor task group, risk management task group, and task group on globalization. Following are highlights of these task groups.

***New Reactor Task Group***

- To facilitate, including in the ASME Codes and Standards, new and revised rules needed by the developers of new reactors
- Hold workshops with reactor suppliers, regulators, engineer/constructors and owners.
- Collect input from stakeholders on new code requirements.

***Risk Management Task group***

- Establish short and long term code initiatives to implement risk-informed technology in all aspects of nuclear code and standard requirements.
- Coordinate these initiatives with ASME code committees and other appropriate standard development organizations developing risk informed nuclear code requirements

***Task Group on Globalization***

- To facilitate the changes in the ASME nuclear code to accommodate its use in countries using power.
- Meet with regulatory authorities of countries with nuclear power facilities to determine the current laws and obtain input on specifying of ASME requirements.

***Status of the Task Groups***

- The new reactor task group has met with four reactor suppliers and three regulatory authorities to obtain input on their code needs.
- Developed a standard for PRA and are working with ANS to coordinate development of additional PRA standards.
- Memorandum of Understanding has been established with several countries in order to facilitate the use of ASME for future nuclear power plants.

**Mike Coyle, Nuclear Operations, NEI**

Mr. Coyle presented on behalf of ANS 28 Committee. This committee has the responsibility to develop a new standard 53.1, "Nuclear Safety Criteria for the Design of Modular Helium-Cooled Reactor Plants (MHR)." ANS 53.1 establishes nuclear safety criteria, functional performance and design requirements. The objective and purpose of ANS 53.1 is to protect public health and safety to enhance development of MHRs. The key attributes of ANS 53.1 Standard is risk-informed, performance-based and is applicable to modular helium cooled graphite reactors. The standard also recognizes inherent, passive safety of MHRs. ANS plans to issue initial draft in November 2005.

## WORKSHOP SUMMARY

The meeting concluded with the general agreement that the workshop was very productive and had provided for a good exchange of information. There are some potential policy issues which need to be resolved. General agreement on the following:

- Concepts in the framework are reasonable and it is feasible to develop this technology-neutral framework and ultimately technology-neutral requirements.
- Resolution for some issues is at a technology-specific level and should be addressed in the technology-specific framework and regulatory guide.
- Need more consistency and conciseness in the language.
- Need more discussion on some of the issues; have some separate meetings focused on different issues: example, on safety classification, emergency planning, containment and how it fits with the framework.
- Need a complete schedule through rulemaking.

Attachments: 1. List of Attendees  
2. Meeting agenda

**Regulatory Structure  
for New Plant Licensing, Part 1:  
Technology-Neutral Framework  
Public Workshop  
March 14-16, 2005**

**MEETING ATTENDEES**

Name	Organization	Telephone	E-Mail
Edward Burns	Westinghouse	7035285975	ed.burns@earthlink.net
Nathan Palm	Westinghouse	412-374-2570	<a href="mailto:palmn@westinghouse.com">palmn@westinghouse.com</a>
Malcolm LaBar	ANS		
Michael Coyle	NEI		
Stephen Mazurkieicz	Framatone ANP, Inc.	434-832-2309	
Mark Cox	Framatone ANP, Inc.	434-832-2308	<a href="mailto:mark.cox@framatome-anp.com">mark.cox@framatome-anp.com</a>
Edward Wallace	PBMR Pty LTD.	423-344-6774	<a href="mailto:edward.wallace@pbmr.co.za">edward.wallace@pbmr.co.za</a>
Christian Sanna	ASME	212-591-8513	
Mario Carelli	Westinghouse	412-256-1042	
Charles Kling	Westinghouse		
Neil Brown	LLNL	925-424-4019	
Marco Gasparini	IAEA		
Bryan Erler	ASME	773-248-6844	<a href="mailto:erlerltd@aol.com">erlerltd@aol.com</a>
John Lehner	BNL		
Vinod Mubayi	BNL		
Trevor Pratt	BNL		
Dennis Bley	Buttonwood Consulting		

Philip Kotwicki	Westinghouse	412-374-6393	<a href="mailto:kotwiccpj@westinghouse.com">kotwiccpj@westinghouse.com</a>
Shawn Burns	SNL	505-844-6200	<a href="mailto:spburns@sandia.gov">spburns@sandia.gov</a>
Amarjit Singh	NRC/RES/DRAA	301-415-0250	<a href="mailto:axs3@nrc.gov">axs3@nrc.gov</a>
Mary Drouin	NRC/RES/DRAA	301-415-6675	<a href="mailto:MXD@nrc.gov">MXD@nrc.gov</a>
Parsad Kadambi	NRC/RES/DSARE	301-415-5896	<a href="mailto:NPK@nrc.gov">NPK@nrc.gov</a>
Stuart Rubin	NRC/RES/DSARE	301-415-7480	
Joseph Williams	NRC/NRR/DRIP	301-415-1470	
Bruce Musico	NRC/NRR/DIPM	301-415-2310	
Marty Stuzke	NRC/NRR/DSSA	301-415-4105	
Daniel Burnett	NRC/RES/DSRAE	301-415-5990	
John Ridgely	NRC/RES/DRAA	301-415-6555	
Med El-zeftawy	NRC/ACRS	301-415-6889	<a href="mailto:mme@nrc.gov">mme@nrc.gov</a>
John Bolin	General Atomics	858-455-2467	<a href="mailto:john.bolin@gat.com">john.bolin@gat.com</a>
Gareth Parry	NRC/NRR/DSSA	301-415-1464	<a href="mailto:gwp@nrc.gov">gwp@nrc.gov</a>
David Lew	NRC/RES/PRAB	301-415-5189	<a href="mailto:dcl@nrc.gov">dcl@nrc.gov</a>
Jim Chapman	Sciencetech, LLC	978-263-5975	<a href="mailto:jchapman@sciencetech.com">jchapman@sciencetech.com</a>
Mark Holbrook	Idaho National Lab	208-526-4362	<a href="mailto:mark.holbrook@inl.gov">mark.holbrook@inl.gov</a>
Kevin DeWall	Idaho National Lab	208-526-0313	<a href="mailto:kevin.dewall@inl.gov">kevin.dewall@inl.gov</a>
Frank Schaaf	sterling refrigeration	585-872-0809	<a href="mailto:treecode@cs.com">treecode@cs.com</a>
Mario Bonaca	ACRS	860-633-6119	<a href="mailto:mvbonaca@snet.net">mvbonaca@snet.net</a>
Tom Kress	ACRS	865-483-7548	<a href="mailto:tskress@aol.com">tskress@aol.com</a>
Karl Fleming	Technology Insights	760-419-3212	<a href="mailto:fleming@ti-sd.com">fleming@ti-sd.com</a>
Fred Silady	Technology Insights	858-455-9500	<a href="mailto:silady@ti-sd.com">silady@ti-sd.com</a>
Charles Ader	NRC/RES/DRAA	301-415-5790	<a href="mailto:cea@nrc.gov">cea@nrc.gov</a>
George Zinke	Entergy/NuStart	601-368-5381	<a href="mailto:gzinke@entergy.com">gzinke@entergy.com</a>
Bruce Musico	NRC/NSIR	301-415-2310	<a href="mailto:bjm2@nrc.gov">bjm2@nrc.gov</a>
Mary Drouin	NRC/RES	301-415-6675	<a href="mailto:mxd@nrc.gov">mxd@nrc.gov</a>
Stuart Rubin	NRC/RES	301-415-7480	<a href="mailto:sdr1@nrc.gov">sdr1@nrc.gov</a>



N. P. Kadambi	NRC/RES	301-415-5896	<a href="mailto:npk@nrc.gov">npk@nrc.gov</a>
Dennis Bley	Buttonwood Cons. Inc.	703-963-6486	<a href="mailto:bley@ieee.org">bley@ieee.org</a>
Vinod Mubayi	Brookhaven Lab	631-344-2056	<a href="mailto:mubayi@bnl.gov">mubayi@bnl.gov</a>
Martin Stutzke	NRC/NRR	301-415-4105	<a href="mailto:mas7@nrc.gov">mas7@nrc.gov</a>
John Lehner	Brookhaven Lab	631-344-3921	<a href="mailto:lehner@bnl.gov">lehner@bnl.gov</a>
Trevor Pratt	Brookhaven Lab	631-344-2630	<a href="mailto:pratt@bnl.gov">pratt@bnl.gov</a>
Amarjit Singh	NRC/RES	301-415-0250	<a href="mailto:axs3@nrc.gov">axs3@nrc.gov</a>
Jean Frejka	Brookhaven Lab	631-344-2349	<a href="mailto:frejka@bnl.gov">frejka@bnl.gov</a>
Neil W. Brown	LLNL	925-424-4019	<a href="mailto:brown93@llnl.gov">brown93@llnl.gov</a>
Charles Kling	Westinghouse	860-731-6604	charles.i.kling@ns.westinghouse.com
Mario Carelli	Westinghouse	412-256-1042	carellmd@Westinghouse.com
Tom King	ADSTM	301-874-5991	thomas-king@astminc.com
Adrian Heymer	NEI	202-739-8094	<a href="mailto:aph@nei.org">aph@nei.org</a>
Frank Cherny	NRC-RES	301-415-6786	<a href="mailto:FCC1@NRC.GOV">FCC1@NRC.GOV</a>
Erasmia Lois	NRC-RES	301-415-6550	<a href="mailto:EXL1@NRC.GOV">EXL1@NRC.GOV</a>
Marco Gasparini	IAEIA	431-260022686	M.GASPARINI@IAEA.ORG
Ed Chow	NRC-RES	301-415-6571	<a href="mailto:ETC@NRC.GOV">ETC@NRC.GOV</a>
Jenny Weil	McGraw-Hill	202-383-2161	<a href="mailto:jenny-weil@platts.com">jenny-weil@platts.com</a>

Monday, March 14, 2005

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TIME		ITEM	PRESENTER/ MODERATOR*
8:30	to 8:50	Introduction, NRC . . . . .	Drouin
		— welcome	
		— opening remarks . . . . .	Carl Paperiello
		— logistics of workshop	
8:50	to 10:00	NRC presentation . . . . .	Drouin
		— Overview of Regulatory Structure for New Plant Licensing, Policy and Technical Issues	
10:00	to 10:30	<b>BREAK</b>	
10:30	to 5:00	Open discussion with stakeholders on Framework and associated policy and technical issues	
10:30	to 11:30	Open Discussion . . . . .	Musico
		— Safety Philosophy (Issue 3, Level of Safety)	
		— Protective Strategies	
		» emergency preparedness (Issue 7)	
11:30	to 12:45	<b>LUNCH</b>	
12:45	to 3:15	Open Discussion . . . . .	Stuzke
		— Risk Objectives	
		— Design, Construction, Operational Objectives; e.g.,	
		» probabilistic approach for DBAs, safety classification, etc (Issue 5)	
		» scenario-specific source terms (Issue 6)	
		» integrated risk (Issue 1)	
3:15	to 3:45	<b>BREAK</b>	
3:45	to 5:00	Open Discussion . . . . .	Rubin
		— Treatment of Uncertainties and Defense-in-Depth (Issue 4)	
		» containment vs confinement (Issue 2)	
5:00	to 5:30	Summary . . . . .	Drouin
		— Discussion on breakout sessions	
5:30		Adjourn	

\*For the Open Discussions, there are not presentations, therefore no “presenter,” but a “moderator.” The role of the moderator is to facilitate the discussion, keep the discussions focused on the topic, keep track of time, calling on panel members to answer questions, to engage in discussion.

## Tuesday, March 15, 2005

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8:30	to	8:40	Introduction, NRC . . . . .	Drouin
8:40	to	9:15	Open discussion with stakeholders on process to develop requirements . . . . . — Performance-Based Concepts — PRA Technical Acceptability	Williams
9:15	to	9:30	<b>BREAK</b>	
9:30	to	10:30	Open discussion with stakeholders on process to develop requirements (continued) . . . . .	Williams
10:30	to	11:00	Stakeholder presentation: Implementation example . . . . .	INEEL
11:00	to	12:15	<b>LUNCH</b>	
12:15	to	3:30	Breakout Sessions (Small, parallel group discussions on various policy and technical issues, to be identified)	
3:30	to	4:00	<b>BREAK</b>	
4:00	to	4:30	Breakout sessions wrapup and prepare summary	
4:30	to	5:30	Presentation by each Session chair	
5:30			Adjourn	

## Wednesday, March 16, 2005

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8:30	to	8:40	Introduction, NRC	
8:40	to	10:00	Solicit specific comments on the working draft NUREG . . . . .	Drouin
10:00	to	10:30	<b>BREAK</b>	
10:30	to	12:00	Formal stakeholder presentations	
12:00	to	12:30	Summary of workshop, NRC . . . . .	Drouin
12:30			<b>ADJOURN WORKSHOP</b> cc: . . . . .	<u>Hard Copy</u>

PRAB r/f  
ACRS (M. Snodderly)  
OGC (G. Mizuno)

E-Mail

NRR:

S. Black  
M. Johnson  
D. Harrison  
G. Parry  
M. Rubin  
M. Tschiltz  
E. Imbro  
M. Stutzke  
B. Musico  
N. Mamish

RES:

C. Ader  
M. Cunningham  
N. Chokshi  
A. Rubin  
M. Drouin  
D. Lew  
A. Singh  
S. Rubin  
C. Paperiello  
J. Craig  
P. Kadambi  
F. Eltawila  
R. Barrett

BNL:

J. Lehner, BNL  
V. Mubayi  
T. Pratt  
D. Bley

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NAME	DWatkins		ASingh		MDrouin		ASingh		Dlew	
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